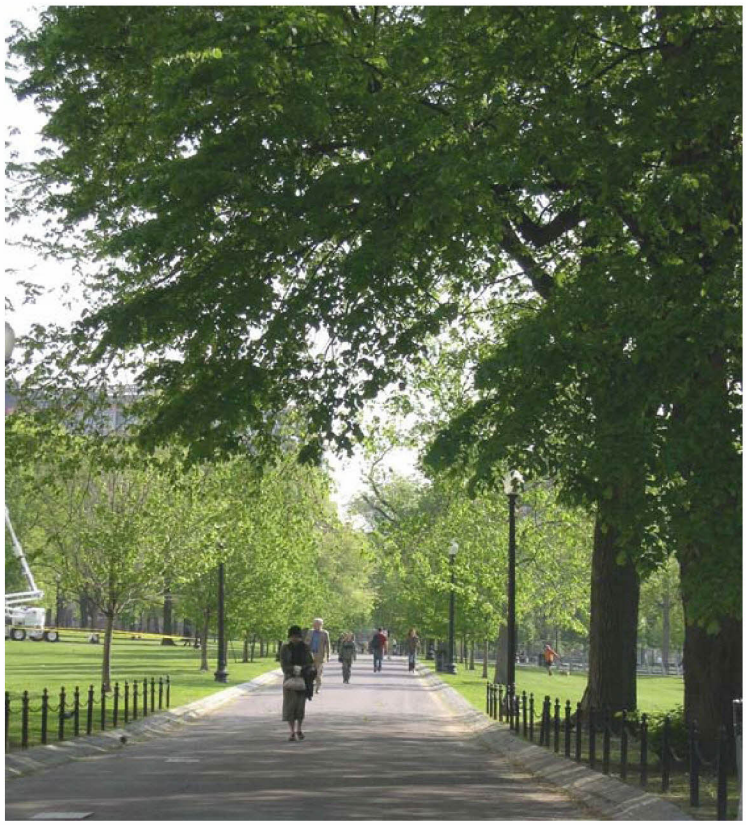

Proceedings from the Chesapeake Bay Scientific and Technical Advisory Committee's Urban Tree Canopy Workshop

May 24, 2004
Annapolis, Maryland

STAC Publication 04-005

Chesapeake Bay Program
A Watershed Partnership

STAC

Forestry Workgroup

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About the Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program on measures to restore and protect the Chesapeake Bay. As an advisory committee, STAC reports quarterly to the Implementation Committee and annually to the Executive Council. STAC members come primarily from universities, research institutions, and federal agencies. Members are selected on the basis of their disciplines, perspectives, and information resources needed by the Chesapeake Bay Program.

For a list of STAC publications and/or to download STAC publications visit the STAC website at www.chesapeake.org/stac

About the Chesapeake Bay Forestry Workgroup

The Chesapeake Bay Program's Forestry Workgroup coordinates, develops, and implements plans and projects which focus on the contributions of forest lands in restoring the health and productivity of the Chesapeake Bay watershed while retaining their economic potential. The workgroup provides a forum to discuss issues and identify opportunities among the forestry community, interested individuals and organizations, and federal, state and local governments. Through the workgroup, natural resource management expertise is brought to Chesapeake Bay Program subcommittees.

For additional copies of this publication, contact:
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Cover photo by Anne Cumming.

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Annapolis Radisson Hotel
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Sponsored by
The Scientific and Technical Advisory Committee
The Forestry Workgroup
The USDA Forest Service

August 2004

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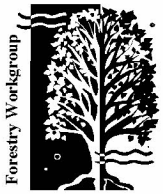
WORKSHOP AGENDA



STAC Urban Tree Canopy Workshop
May 24, 2004
Annapolis, MD

Objectives:

1.) Clarify how urban tree canopy cover provides significant benefit in addressing the goals of the *Chesapeake 2000* agreement.
2.) What is an appropriate canopy cover goal for urban watersheds to produce a measurable water quality benefit?

Morning session: Clarify how urban tree canopy cover provides significant benefit in addressing the goals of the *Chesapeake 2000* agreement.

8:30 a.m. Registration

9:00 a.m. Introduction: Overview of Chesapeake Bay Program
Al Todd, USDA Forest Service, Chesapeake Bay Program Office

9:30 a.m. Assessing Quantity and Quality of Urban Tree Canopy
Dave Nowak, USDA Forest Service, Northeastern Research Station

10:30 a.m. Break

10:45 a.m. Data Sources and Methods of Quantifying Canopy Cover
Fred Irani, Maryland Department of Natural Resources

11:15 a.m. Impacts of Urban Tree Canopy on Water Quality: Results of a Montgomery County, MD Study
Scott Goetz, Woods Hole Research Center

12:00 p.m. Lunch
Effects of Urban Tree Canopy on Nutrient Runoff
Tom Schueler, Center for Watershed Protection

Afternoon session: What is an appropriate canopy cover goal for urban watersheds to produce a measurable water quality benefit? What are the recommended methods and guidelines for assessment, goal setting, and implementation?

1:00 p.m. Canopy Cover in the Chesapeake Bay Watershed: Methods and Data
Dave Nowak, USDA-Forest Service, Northeastern Research Station

1:30 p.m. Breakout Groups
- Assessment
- Goal Setting
- Implementation

3:15 p.m. Break

3:30 p.m. Workgroup Reports

5:00 p.m. Summary and Conclusion

INTRODUCTION

Greetings –

It is a pleasure to introduce the proceedings from the Chesapeake Bay Scientific and Technical Advisory Committee's (STAC) Workshop on Urban Tree Canopy. The workshop was created to help partners implement the urban canopy cover goals of the Riparian Forest Buffer Directive No. 03-01, signed by the Chesapeake Executive Council in December 2003. This expanded riparian buffer directive "...recognizes that urban tree canopy cover offers stormwater control and water quality benefits for municipalities in the Chesapeake Bay watershed and can extend many riparian forest buffer functions to urban settings." The directive commits to, among others, the following goals:

- By 2010, work with at least 5 local jurisdictions and communities in each state to complete an assessment of urban forests, adopt a local goal to increase urban tree canopy cover and encourage measures to attain the established goals in order to enhance and extend forest buffer functions in urban areas; and,
- Encourage increases in the amount of tree canopy in all urban and suburban areas by promoting the adoption of tree canopy goals as a tool for communities in watershed planning.

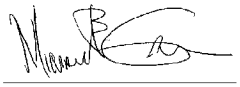
To facilitate accomplishment of these goals, the Chesapeake Bay Program and agencies of partner jurisdictions committed to "Expand the state of our knowledge about the role of urban tree canopy in supporting riparian buffer functions in cities and urbanizing communities. Develop science-based tools to quantify the benefits of an urban canopy for communities in the Bay watershed and research methods for crediting narrower buffers in urban areas."

The STAC Workshop on Urban Tree Canopy and the resulting proceedings are technology transfer tools intended to help you accomplish these goals. The workshop and proceedings intend to assist you in:

- Understanding the role of urban tree canopy cover in addressing the goals of the *Chesapeake 2000* agreement;
- Learning about various data sources for, and methods of, quantifying tree canopy cover;
- Learning how to set appropriate canopy cover enhancement goals; and,
- Strategies for implementing those goals.

It is very exciting to see the important role urban forests can play in addressing urban ecosystem health issues formally recognized by the Chesapeake Bay Program. We very much appreciate your partnership in our efforts to restore the Bay and hope that these tools will be of considerable practical value to you as a partner in this most important endeavor.

Best regards



Michael F. Galvin, Chair
STAC Workshop on Urban Tree Canopy Steering Committee

Benefits of Urban Forests

Al Todd and David Nowak, USDA Forest Service

Trees in urban areas provide a great number of environmental and societal benefits. These benefits include:

Environmental Benefits

- *Reduced air and surface temperatures*—urban trees cool both ambient and surface temperatures by providing shade and transpiring water, thereby helping to counteract the "urban heat island effect" created by large expanses of impervious surfaces in urban areas.
- *Energy use savings*—trees near buildings provide shade that helps to keep buildings cool in the summer. In the winter, trees help keep buildings warm by blocking winter winds, but can cool buildings when branches block solar radiation. Trees should be strategically planted to maximize energy savings to residents and businesses—generally west of the building is the best location.
- *Reduced ultraviolet (UV) radiation loads*—trees absorb about 96 percent of UV light, thus protecting many species—including humans—from these damaging rays.
- *Improved air quality*—urban trees not only cool air temperatures, but they also remove pollutants such as nitrogen oxides, carbon monoxide, and ozone from the air. In addition, by reducing building energy use urban trees can decrease power plant emissions. It should be noted that trees do emit volatile organic compounds (VOCs) into the air that contribute to ozone formation, but VOC levels vary by tree species. However, integrated studies are revealing that increased urban tree cover leads to reduced ozone concentrations.
- *Carbon sequestration*—trees help to counteract factors contributing to climate change by taking up carbon dioxide from the air.
- *Improved water quality*—tree leaves, branches, and stems improve water quality in urban areas by intercepting, absorbing, and storing rainfall, filtering pollutants, reducing runoff and erosion, and shading streams. Urban trees can be utilized as innovative stormwater management tools.
- *Wildlife habitat*—urban forests provide habitat and food for a variety of fish, birds, and other wildlife in urban areas. They can serve as corridors for migratory species.
- *Stream Ecology*—the engineered stream drainage system of urban areas depletes streams of organic matter by changing streams' hydrologic patterns. Leaf litter and woody debris from well-canopied urban areas can help to replenish this important food resource to urban streams and thus maintain the species richness and diversity of stream biota.

Societal Benefits

- *Enhanced quality of life*—urban residents benefit from the trees in their cities in many ways. Among these are health benefits from cleaner air, UV protection, and clean water. In addition, green urban areas have been shown to improve the psychological well-being of residents. Trees also reduce noise levels in urban areas.

- *Economic benefits*—in addition to energy cost savings, urban forests also contribute to increased property values and improved aesthetics of communities. Further, they can reduce stormwater management costs of communities.
- *Social benefits*—urban trees facilitate a connection with natural resources for those in urban areas. They also provide opportunities for community events and educational opportunities.
- *Promotion of "Smart Growth" principles*—in addition to beautifying communities, urban trees contribute to pedestrian-friendly streetscapes and enhance communities' economic stability by attracting businesses and tourists. Studies have shown that people linger and shop longer along tree-lined streets; apartments and offices in wooded areas rent more quickly, have higher occupancy rates and tenants stay longer; and businesses leasing office space with trees have more productive workers and less absenteeism.

The Chesapeake Bay Program's Urban Forestry Goals

Al Todd, USDA Forest Service

The Chesapeake Bay watershed is a very unique system for many reasons. In particular, the Bay is very shallow and the watershed's land area is quite large—a ratio of 2743 km^2 of land to one km^3 of water. (The Gulf of Finland has the next highest ratio at 382:1) The result is that activities on the land greatly impact the condition of the water in the Bay. Eighty to 90 percent of the watershed's population lives in urban areas, and land is being consumed and converted to development at three times the rate of population growth. In addition, over 75 percent of water in urban areas does not infiltrate into the ground as a result of impervious areas, stormwater management, and soil compaction. Further, urban land produces 11 percent of the nitrogen and 17 percent of the phosphorous from non-point sources, and 20 percent of the nitrogen and phosphorous for point sources. This is a disproportionate contribution given that urban land accounts for only seven percent of the land area in the watershed.

For all of these reasons, and given that urban trees do provide so many environmental and social benefits to communities, the Chesapeake Bay Program formally recognized the importance of urban trees in the *Chesapeake Executive Council's Expanded Riparian Forest Buffer Goals* (Directive 03-01) signed in December 2003. Over the next six years, the Chesapeake Bay Program and its partners will work to implement the new goals (listed on page 3) of this directive.

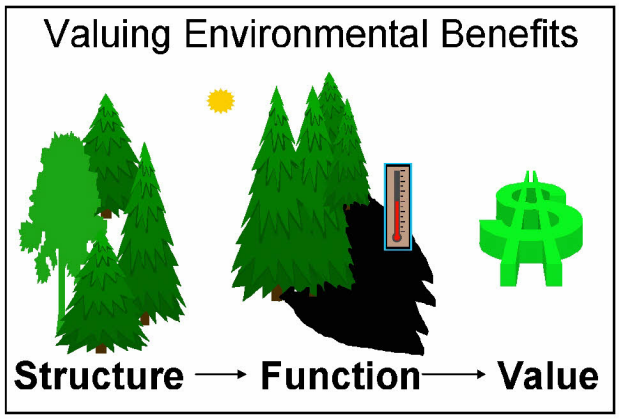
ASSESSMENT OF URBAN TREE CANOPY

Taking a strategic approach to improving a community's urban forest requires understanding the condition of the existing urban forest. Assessing the urban tree canopy provides the first step in moving towards improved watershed conditions through setting community goals and enhancing the tree canopy.

Assessment Approaches

David Nowak, USDA Forest Service

Changing the structure of the urban environment changes the function of that environment which changes the value the environment provides for humans and other species. So in order to maximize the value of the urban forest, we must have an understanding of its structure. There are two basic approaches to assessing the urban forest—"top-down" aerial assessment and "bottom up" ground-based assessment.



David Nowak, USDA Forest Service

Aerial Assessment Approaches

There are several available data sources for conducting an aerial assessment of urban tree canopy. These images can be analyzed using software to map out tree, grass and impervious cover. In addition, a low-cost, quick photo interpretation program is available on the Internet, www.fs.fed.us/ne/syracuse/Tools/tools.htm, for use to determine canopy cover from these digital images. Types of images available to assess canopy cover are:

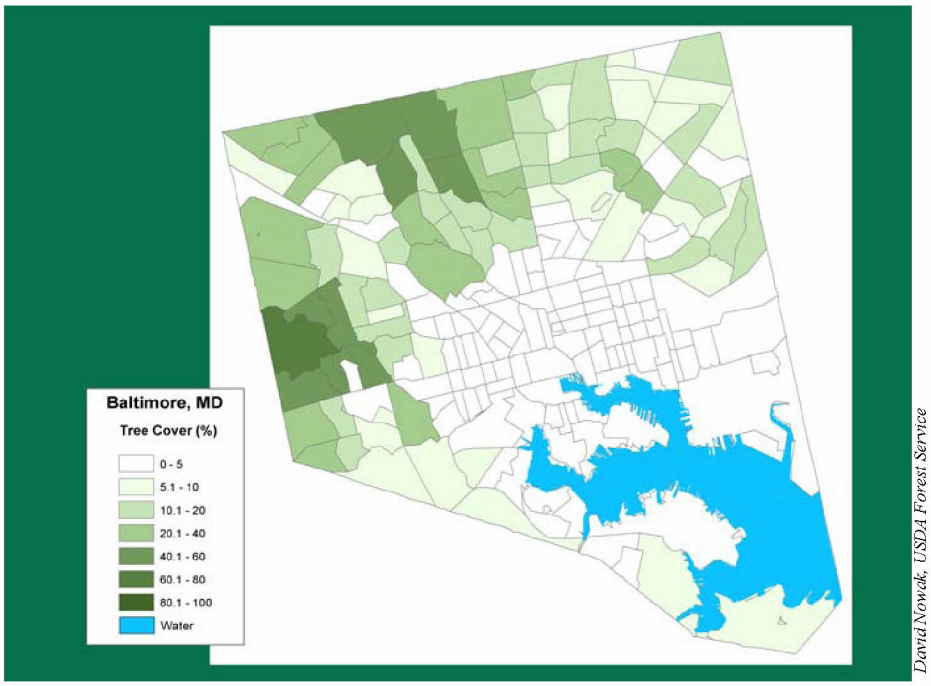
1. Digital orthoquad (DOQ) infrared images from the 1990s at one meter resolution from US Geological Survey (trees reflect very highly in infrared). These images are available at little or no cost.
2. Digital CIR photographs at sub-meter resolution flown by private corporations. Analyses of these "leaf on" photographs are typically 80-90 percent accurate (e.g., trees sometimes get confused with grass).
3. High resolution (one to four meter) satellite imagery (such as IKONOS).
4. Landsat data from satellites at 30 meter resolution. These images are useful for assessing a larger region. The USGS and other cooperators are working on national maps of percent tree and impervious cover. The average pixel

David Nowak, USDA Forest Service

Digital orthoquad images (1m resolution) can be utilized to assess tree canopy.

error of these analyses is typically less than 15 percent, and the accuracy improves as pixels are grouped together.

It should be noted that in some cases aerial assessment may underestimate tree cover in urban areas where large buildings cast shadows over trees. In addition, aerial assessment currently does not allow a calculation of leaf area index in urban areas, which is used in models to estimate environmental benefits of an urban forest. Ground based assessments must be conducted to determine leaf area index.



An urban tree canopy map of Baltimore, Maryland developed as part of the Chesapeake Bay ecoregion canopy assessment.

A tree canopy cover assessment of the Chesapeake Bay ecoregion (a subset of the Chesapeake Bay watershed) has been completed using Landsat data. It is estimated that by 2007, assessments will be complete for the entire country. It is hoped that future updates will examine the change in cover for urban areas every ten years.

Ground-Based Assessment Approaches

Ground-based assessments take a "bottom-up" approach to urban canopy assessment. This approach requires on-the-ground data collection for a sample of urban trees in a given area. Data are collected on several characteristics including tree species, height, diameter at breast height, condition, crown parameters, and proximity to buildings. A field manual for this collection is available on the Internet, www.fs.fed.us/ne/syracuse/Tools/tools.htm, and a national sampling protocol as well as programs for collecting these data on palm pilots is under development.

After collection, the field data can then be entered into the Urban Forest Effects (UFORE) Model, www.fs.fed.us/ne/syracuse/Tools/UFORE.htm, to develop a three-dimensional estimate of canopy coverage, leaf area index, and biomass of the urban forest. The UFORE Model can also be used as a management tool to conduct air quality assessments and to quantify:

- Air pollution removal (hourly to yearly)
- VOC emissions (hourly to yearly)
- Structure (e.g., species composition)
- Annual carbon storage and sequestration and value
- Seasonal effects on building energy use and associated energy costs
- Pollen allergenicity index

- Tree transpiration / water use (hourly to yearly)
- Pest potentials

In the future, this model will be able to assess water quality contributions of the urban forest as well. Preliminary tests of this new hydrology model simulate hourly flow rates with about a 70 percent accuracy rate. Inaccuracies in simulating actual flow rates are typically due to limitations (e.g., geographical separation) in weather and gauging station flow data.

Data Sources and Methods for Urban Tree Canopy Assessment

Fred Irani, Maryland Department of Natural Resources

The data and the assessment approach that a community uses for assessing its urban canopy will be driven by the money and technical capacity of the community. There are three basic approaches a community can use: to utilize existing analysis of existing data, to reassess existing data, or to acquire and assess new data. The more high tech approaches require a greater investment but can produce much more detailed results.

Utilizing existing analyses of existing data—this is the low cost, low tech approach to get a general overview of the canopy cover of an area. One general resource that provides canopy cover estimates for census-designated places is the USDA Forest Service's General Technical Report—*Connecting People with Ecosystems in the 21st Century: An Assessment of Our Nation's Urban Forests* (PNW-GTR-490), www.fs.fed.us/pnw/pubs/gtr490/gtr490.pdf.

Reassessing existing data—this approach requires some level of ArcView technical ability to click and classify data from existing images.

Acquiring and assessing new data—this is the high tech and more costly approach to assessing urban tree canopy with high resolution spatial data. A local community might be able to use this approach through a partnership with a local university or a state or federal agency.

When determining which approach should be used, the group conducting the assessment should consider the following questions:

- What resolution is needed?
- What investment can be made?
- What does the assessment need to determine?
- What area needs to be included in the assessment?
- How accurate does the assessment need to be?
- When does this assessment need to be completed?
- What data and information exist?
- What data and information are needed?
- What technical capacity is available?
- Who needs to be involved in the assessment?
- What will be the product(s) of the assessment?
- What are the next steps?

Questions to consider when utilizing existing images include:

- Is the spatial accuracy and detail too generalized or too coarse?
- Do the data pertain to the exact area of interest?
- Are the data outdated?
- Do the data serve the immediate purpose?
- Will this serve as a baseline number for future updates?
- Are the data readily available?
- What is the cost of the data? Is it free or of nominal cost?
- What interpretation and analysis tools are needed to reanalyze the data?

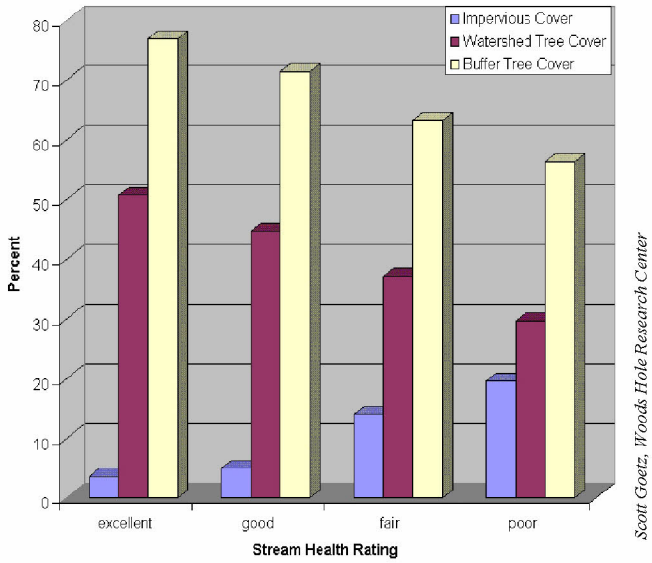
Questions to consider when acquiring new data:

- What specific purposes do the data need to serve?
- What seasonal factors will affect the data? (leaves on/off, season, sun angles, haze)
- Will the new data be compatible with existing data?
- Will the data collection be repeatable? (for temporal studies)
- What will the accuracy be?

Montgomery County, Maryland Urban Canopy Case Study

Scott Goetz, Woods Hole Research Center

High-resolution imagery from the IKONOS satellite was used to assess tree cover, impervious surfaces, and riparian buffer zones in the urbanized county of Montgomery County, Maryland. This study was able to achieve 97.3 percent accuracy—comparable to manual aerial photo interpretation. This technique facilitated a consistent assessment over an area that would be difficult to accomplish with traditional photographic mapping methods.



Stream health steadily declines as the impervious cover increases and watershed tree cover and riparian buffer tree cover decrease.

There were a number of "lessons learned" about the logistics of using IKONOS data in this process. These included: IKONOS missed detecting some small roads due to leaf cover, acquisition of images took over two years, IKONOS is able to detect narrow riparian buffer areas, and the cost per unit area was a nontrivial consideration. In addition, IKONOS imagery allows you to map "tree cover" from individual trees in urban areas (such as backyards and street trees)—as opposed to "forest cover" which maps only larger forested areas.

In this study, the researchers were able to link stream health ratings (based on physical and biological metrics and an index of biotic integrity) to the percent of impervious cover, the

percent of tree cover in the riparian area, and the total tree cover in the watershed. Statistics were extracted for 246 watersheds in the county (HUC 14 scale) which showed consistent trends. The stream health rating was most strongly correlated to impervious cover, although there was also a strong relationship with tree cover in the riparian areas. The relationship with landscape configuration/total tree cover in the watershed appears to be secondary. Below is a summary of these results which were used to develop a statistical model for predicting stream health.

Stream Health Condition	Percent Impervious	Percent of Riparian Area Buffered
Excellent	<6%	>65%
Good	<10%	>60%

This analysis is now being conducted for the entire Bay watershed using Landsat-based maps of impervious cover and tree cover ("RESAC" data).

Breakout Group Recommendations for Assessing Urban Tree Canopy

Facilitated and compiled by Al Todd, USDA Forest Service and Ainsley Caldwell, District of Columbia Urban Forestry Administration

Assessments of tree canopy can take on several dimensions of complexity depending upon available information and the ultimate use of the canopy data.

What is an assessment used for?

- To help communities set a canopy cover goal
- To predict and track benefits and value for air quality, carbon sequestration, energy conservation, stormwater reduction and water quality improvement; canopy cover serves as a proxy for estimating these benefits
- To provide context for urban tree planting and conservation efforts
- To identify linkages with other environmental practices in urban areas
- To illustrate habitat benefits and linkages
- To show change and identify threats or progress

Type 1: Canopy extent and coverage. The most basic form of assessment represents no more than an approximation of the percent of an area covered by tree canopy as viewed from above. This essentially represents a two-dimensional look at the urban forest and translates into a canopy cover percentage. A refinement of this level of assessment would also provide spatial mapping of this canopy in order to identify differences in conditions across a city or community from dense urban to exurban landscapes. In most cases, this level of assessment can be completed through remote sensing methods such as aerial photography or satellite-based land cover data.

Type 2: Structure and Function. Identification of the characteristics of the canopy cover and the forest and individual trees producing the canopy is a higher level of assessment. The urban forest inventory data required by such programs as the USDA Forest Service Urban Forest Effects Model (UFORE) are an example of the three-dimensional forest characteristics suitable

to not only identify canopy characteristics but also to predict functions and benefits, such as water quality and quantity functions, habitat value and air quality mitigation potential, with some reliability. The benefit(s) to be estimated will determine the data needs of the assessment. This level of assessment would require both remotely sensed as well as field collected data on tree species, age, size, leaf area index, understory conditions and tree condition. An assessment that includes field inspection also allows for identification of local reforestation opportunities. Citizen volunteers can be utilized in collecting field data.

Type 3: Trends/Tracking. In addition to area-specific canopy extent and site-specific urban tree characteristics, an assessment may also include the collection of information on measurement of temporal change in these characteristics. This type of assessment allows determination of trends and the modeling and prediction of future conditions. This type of assessment also includes tracking implementation of tree planting efforts. Other benefits of measuring change in canopy include an ability to: track on-the-ground investments, track loss of forest canopy and changes in canopy characteristics, and predict cumulative benefits.

Existing Assessments: What information do we currently have?

- National data for most cities (USDA Forest Service Urban Forest Assessment)
- 1990 and 2000 impervious cover for Bay watershed (RESAC)
- 1990 and 2000 land cover for Bay watershed
- FIA/FHM ground data
- Forest density/Proportional forest cover for Bay watershed (RESAC)
- Dave Nowak – Place-based canopy percentage and tree characteristics for Baltimore and other selected cities. DC data collection under way.
- Data on tree cover in the buffer zone (Goetz study, Bay Goal Language, CWP data, etc.) 65%-70% tree buffers
- IKONOS imagery available for purchase
- Remote sensing – aerial photographs
- Data will be available soon to refine canopy benefit predictions (Nowak/UFORE)

Other possible future sources: Homeland Security, Department of Defense, etc.

What is the appropriate scale for assessment of tree canopy percentage?

These assessments can be made from regional information but should include a local refinement with better data. Remotely sensed data is appropriate with a Type 2 assessment at local scale to add depth to data. For example, Montgomery County has set tree cover goals but may still have more specific community tree canopy goals for individual towns or communities like the City of Rockville or Gaithersburg. DC has adopted the American Forests target of 40 percent as an overall goal, but may establish more detailed canopy goals for specific watersheds like the Anacostia or communities or Wards.

Nested assessments – Nested goals

Every assessment and goal needs to have a tangible, defined management unit with boundaries for which it is completed. The "Unit" could be at a variety of scales but must have some "legal" or jurisdictional identification and/or responsibility. More detailed and refined assessments

within larger scale regional goals are likely. For example, county to watershed to community to facility/site.

Is it important to define "urban" to define the boundaries of the assessment area?
Yes, and the key focus is on developed and developing areas with assessment goal setting done by clearly defined jurisdiction. This should be an inclusive definition – land use or impervious area may provide definition. GIS shapefiles delineating urban boundaries according to the US Census Bureau are available for download at: www.census.gov/geo/www/tiger/index.html.

How often do we update assessments?

- Canopy/cover on a 5(local) to 10(regional) year basis
- Ongoing tracking of investments should be annual (tree planting, reductions of impervious surface, etc.)
- Tracking should include losses also – death, blow down, removal, land clearing, etc. (An Urban FHM would be desirable for values)

Need the ability to provide technology assistance to the local level to guide these assessments.

- Share examples
- Training for local groups and communities
- Urban tree canopy assessment toolbox
- Technology and organizational assistance for goal setting
- Baseline assessment for regional/state and local
- Guidance on how to track changes in canopy

SETTING URBAN TREE CANOPY GOALS

Once a community has completed an urban canopy assessment, they can use this understanding of current urban forest conditions to set urban tree canopy goals for maintaining and enhancing their urban forest.

Establishing Canopy Goals Using a "Leafout Analysis"

Tom Schueler, Center for Watershed Protection

"Leafout Analysis" is a tool being developed by the Center for Watershed Protection (CWP) that may be useful to communities in establishing urban tree canopy goals. This tool has four primary steps as follows:

1. Inventory current forest cover in the watershed
2. Project future forest loss based on zoning buildout analysis
3. Adjust forest cover to account for local forest conservation and reforestation strategies
4. Use results to set forest cover/canopy goals and select best combination of urban forestry tools to achieve them

Data layers needed for this tool include: watershed/subwatershed boundaries, land cover, protected lands, parcel data, vacant lands, zoning, land in public ownership, natural resources, and topography.

CWP proposes the following as general guidelines for setting forest cover goals:

Type of watershed	Percent impervious cover	Percent forest cover goal	Benefits	Approaches
Rural	0-10%	65% 65% riparian areas	Maintain aquatic ecosystem Improve filtering capacity Wildlife habitat	Prevent Forest Loss During Development Conserve Priority Forests Reforest Private Land
Surburban	11-25%	40% 50% suburban residential	Stormwater runoff reduction Wildlife habitat Reduce urban heat island	Conserve Priority Forests Prevent Forest Loss During Development Landscaping/Street Trees
Urban	26-60%	25%	Stormwater runoff reduction Reduce urban heat island Wildlife habitat	Conserve Priority Forests Reforest Public Land Maintain Existing Forest Canopy
Ultra-urban	>60%	15%	Reduce urban heat island Recreation/aesthetic benefits	Conserve Priority Forests Restore Forest Remnants Maintain Existing Forest Canopy

CWP is producing a 3-part manual on "Using Trees to Protect and Restore Urban Watersheds" which contains additional information about the "leafout analysis," setting forest cover goals, and tree planting in urban areas. This will be completed later in 2004 and available from CWP at www.cwp.org.

Breakout Group Recommendations for Setting Urban Tree Canopy Goals

Facilitated and compiled by Judy Okay, Virginia Department of Forestry and Diane Wilson, Pennsylvania Department of Environmental Protection

What constitutes a "community" or "jurisdiction" as written in the directive?

- Whoever identifies themselves
- Small nested watersheds (8 digit HUC)
- Should standardize community type across the watershed

At what scale should goals be set?

- By zoning
- Relative to opportunities presented
- By zip code

What does a canopy cover goal look like? What should be required of a local jurisdictions goal in order for it to count toward the Bay Program goal? (Monitoring/ tracking component? Certain percentage increase? Certain scale? Timeline? Approval process? Community involvement?) How should we standardize the Goal?

- Link tree cover goals with open space goals
- Help meet existing elements of air quality, stormwater quality (not just canopy)
- Dependent on land use
- There should be a correlation between impervious surface coverage and the percent canopy cover set as a goal—that is areas with high impervious surface should be prioritized for areas of canopy enhancement
- Simple benchmark
- Realistic-scientifically based (regression analysis)
- Prioritization with water quality needs first
- Better protection of existing canopy should be included
- A net gain - maintaining and planting
- No net loss Bay wide in any jurisdiction
- The definition of "urban tree canopy" should include canopy of trees protected from development as well as canopy of trees that are newly planted
- Include stormwater management and infiltration
- Prioritize where to plant
- Use different milestones (relate to when benefits are/will be available)
- Include objectives for planting and tree preservation in goals

What level of community involvement is needed and/or desirable in setting a goal? How can you best engage community members in the goal setting process?

- Provide financial incentives to five communities per state that will count toward meeting the Chesapeake Bay Program goal
- Include community level staff that will plant and maintain trees (work force)
- Involve office of planning and design, office of development and department of public works
- Community involved in watershed management would be a good target group

- Include Open Space acquisition groups/agencies (land trusts and government)
- Criteria for involvement:
  - Trained in tree stewardship
  - Number of organizations
  - Number of volunteers available
- The highest level buy off in the community should be solicited
- Community should have a plan and set its pace
- Validate that resources are available to do the work
- Have a validated track record

What constitutes adoption of a tree canopy cover goal? Does this require a written agreement? A public announcement? Registration with the state or the Bay Program? Who ultimately signs off on it?

- Set minimum standard for the goal
- Reporting is needed
- Show relationship to state buffer goal
- Advocacy for adoption
- Regulation
- Sign up for training
- Resolution by county or city council
- Announcement by states (opportunity offered)
- Commitment to adopting urban forest management plan
- Adopted by a governing body
- Incorporation into zoning codes

Other ideas from breakout group discussion:

- The goal should be tied to open space plans/goals
- Maryland Forest Conservation Boards should be involved
- PA and VA Conservation Districts should be involved
- Sustainability and survivability should be included in the goal
- Oversimplification of goal setting as tree canopy (ignores biodiversity issues)
- Official recognition needed (Tree City USA)
- Tree giveaways as incentives

IMPLEMENTATION OF URBAN TREE CANOPY GOALS

After setting canopy cover goals, communities need to mobilize to take action to implement policies and activities which conserve and enhance their urban forests.

Strategies for Increasing Canopy Cover

Tom Schueler, Center for Watershed Protection

Watersheds are both gaining and losing forest cover at the same time. As such, restoration of watersheds through urban forestry can best be accomplished through a systematic approach that addresses conservation and defines reforestation potential of an urban area. Forest loss can be sharply reduced through establishing local forest conservation goals, but ultimately the extent of impervious surface coverage will determine a community's ability to meet it canopy cover goals.

Techniques for enhancing urban forests and increasing canopy cover include:

- Conserve priority forests
- Restore forest remnants
- Reforest public land
- Reforest private land
- Maintain existing forest canopy
- Prevent forest loss during development
- Landscaping (including street trees) for new development

There are many opportunities for reforestation within existing urban settings. Urban lawns account for 66 percent of turf area in the country—these areas present a significant opportunity for reforestation in urban areas. Priority reforestation sites include:

- Schools
- Parks
- Highway rights-of-way
- Vacant lots
- Streams and shorelines
- Stormwater dry ponds
- Utility corridors
- Home lawns

Center for Watershed Protection

Urban lawns present significant opportunities for reforestation. They account for 66% of turf area.

Developing a Planting Index

David Nowak, USDA Forest Service

A planting index can be developed to determine where trees should be planted and which species should be planted to maximize the benefits of the urban forest. This GIS-based tool can be weighted for a community's specific priorities—such as environmental equity, air pollution removal, and water quality enhancement.

Further a "Growout Model" can be used as a management tool to estimate the number of trees that should be planted each year to achieve a community's urban canopy goal—taking into account the survival rate of new planting. For more information on this model contact David Nowak at dnowak@fs.fed.us.

Breakout Group Recommendations for Implementation of Canopy Enhancement Strategies

Facilitated and compiled by Mike Foreman, Virginia Department of Forestry, and Rob Corletta, Arlington County, Virginia

Should there be criteria for participating communities? Should communities be required to develop an implementation plan that includes certain criteria?

- The criteria used for designating participating communities should be flexible since implementation will be unique for each entity.
- Local governments that have demonstrated a level of concern about urban forestry (for example Tree City status) should be the targets. This will also increase their recognition.
- Indices of progress could be used as a mechanism to track/monitor implementation.
- Communities should have the regulatory and inspection infrastructure necessary to implement a canopy goal.
- The repeatability of the canopy analysis should be a criterion.

What is an appropriate framework to achieve desired goals?

- A written plan that is adopted by the jurisdictions government should be required.
- Annual progress reports will be necessary.
- Goals and priorities for a jurisdiction's canopy increase should be developed by the community.
- Mortality of planted trees should be tracked.
- The ability to track maintenance activities is important.
- A reporting mechanism needs to be created to track implementation progress.
- Outreach efforts should be tracked as well.
- Does there need to be a top down approach in dictating the canopy goals? Does it need to come from the Bay Program?
- An educational component should be required.
- Efforts for the protection and preservation of existing trees should also be a requirement.

- Top down oversight (by the Bay Program) of participating communities will be necessary to reach non-participating communities.
- Local leaders should be targeted to establish green infrastructure credits, natural area credits and riparian buffer credits.
- A centralized database needs to be considered at the Bay Program level.
- Canopy goal should not be isolated from other Goals and subcommittee commitments at the Bay Program.

Who is the main audience for education and outreach efforts—the jurisdictions themselves or the residents (or both)?

- Residents, including garden clubs and Master Gardeners as well as non-traditional audiences should be targeted.
- Politicians and other potential local champions should be targeted.
- Engineers and the development community should be targeted.

Who/what group or agency will have the primary responsibility for implementing?

- The local jurisdiction/entity should adopt the canopy goal and be responsible for implementation.
- Many agencies could be involved in implementation. This would be a demonstration of partnership.
- Implementation would be at the local level. However, there could be more levels held accountable for success.
- The entity responsible for implementation could even be a non-profit.
- Funding and incentives may be required.

How can you best facilitate/coordinate efforts between local governments, non-profits, schools, homeowner associations, etc?

- Baltimore is a great example for facilitation and coordination.
- Funding will be a crucial issue.
- The collaboration between the District of Columbia Urban Forestry Administration and Casey Tree Fund may be an example.
- Pennsylvania has a good model of coordination between the Urban Forestry Council, Penn State and the Department of Conservation and Natural Resources.
- The private groups helping to fund Bay restoration efforts would be useful to contact.
- Chicago Wilderness is also a good example of facilitation and coordination.

What can be done to encourage planting and conservation on private residential and commercial land?

- Tax incentives may be a useful tool.
- Providing money for planting initiatives is always an encouragement.
- Cost sharing programs are useful, including discounts and training (citizen foresters).
- The survivability of plantings is always an issue. A possible measure to help with survivability is conservation easements. However the restrictions associated with the easement need to be considered such as harvest rights or perpetuity clauses.

- Local landscape requirements and/or ordinances could be changed to encourage planting and conservation.
- The enforcement of planting requirements is a challenge to most communities.
- Education is crucial to encouraging planting and conservation. This should include environmental benefits and appraised value of trees. The desired planting objectives must be considered.
- An "urban tree registry" may help with conservation.

What are the best methods to encourage conservation as well as planting?

- Education
- Targeting networks of activists in your community.
- Practice of conservation (tree preservation) can be incorporated into current regulations.
- Establish award programs for successful conservation efforts.
- Best Management Practices for tree preservation should be established for parking lots and stormwater management projects. Adequate technical transfer is necessary for this to be successful.
- Having a "Champion" for tree conservation in your community is always very useful. Often it is most effective when this individual is a politician.

Possible Tools for achieving canopy Goals

- Zoning ordinances with tree preservation provisions
- Outreach to private property owners
- Create incentives for tree planting and preservation
- Non-profit partners (especially for private property initiatives)
- Green infrastructure planning tied to quality of life
- Communicating the variety of benefits trees provide including increased property values
- Innovative parking lot design that includes tree planting and preservation

APPENDICES

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Speaker Biographies

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Scott Goetz works on the application of satellite imagery to analyses of environmental change, including monitoring and modeling links between land use change, forest productivity, biodiversity, and ecosystem health. Before joining the Woods Hole Research Center in 2003 he was on the Faculty at the University of Maryland for 7 years, where he maintains an adjunct associate professor appointment. He was a research scientist at the NASA Goddard Space Flight Center from 1985 to 1995. He has authored, to date, more than 40 refereed journal publications, and recently edited a special issue of *Remote Sensing of Environment* on advances in biophysical remote sensing. He graduated from the Pennsylvania State University (BS), the University of California (MS), and the University of Maryland (PhD).

Frederick M. Irani
Remote Sensing and GIS Specialist
Maryland Department of Natural Resources, Landscape and Watershed Analysis Division

Frederick M. Irani is the Remote Sensing and GIS specialist for the Landscape Analysis Section, Landscape and Watershed Analysis Division of the Maryland Department of Natural Resources (DNR) Watershed Services. He has a Masters of Science in Geography from the Pennsylvania State University, 1984. The theme of his Master's Thesis was the design and implementation of a raster based software system called the Land Use and Land Cover Information Display System (LIDS) which produced maps and aerial statistics from USGS land use and land cover data. He worked for twelve years at the NASA Goddard Space Flight Center in Greenbelt, Maryland as principal analyst programmer and task leader for the design, implementation, distribution and support of the Land Analysis System (LAS): a robust Image Analysis (IA) software system consisting of over 200 individual IA application programs and supporting software routine libraries. He has been at the Maryland DNR since 2000 providing GIS and Remote Sensing support for projects ranging from Chesapeake Bay shore erosion response recommendations with DNR Coastal Zone Management, to urban tree canopy assessment with the DNR Urban Forestry Division.

David Nowak, Ph.D.
UFORE Model Project Leader
U.S. Department of Agriculture Forest Service, Northeastern Research Station

David Nowak has worked for the Forest Service, an agency in the United States Department of Agriculture, for about 13 years. He is currently the Project Leader of a research unit of the Northeastern Research Station, located in Syracuse, New York. The mission of the research unit is to understand and quantify the effects of urban forests and their management on human health and environmental quality. In the early 1990s he was a principal scientist on the Chicago Urban

Forest Climate Project and is a recipient of the American Forests Urban Forest Medal recognizing outstanding national contributions in urban forest research.

Tom Schueler
Director of Watershed Research and Practice
Center for Watershed Protection

Tom Schueler founded the Center for Watershed Protection in 1992 with the mission to protect and restore our nation's watersheds. He has a keen interest in the science and management of urban streams, and has worked for more than 20 years on practical techniques for protecting and restoring them. Tom has authored several widely-used references, including The Practice of Watershed Protection, Rapid Watershed Planning Handbook, Better Site Design, and Design of Stormwater Wetland Systems. He co-authored the Maryland Stormwater Design Manual and has developed new approaches to use impervious cover as an environmental indicator and management tool for watershed planning. From 1982 to 1992, Tom worked at the Metropolitan Washington Council of Governments, where he led the Anacostia Watershed Restoration Team.

Albert Todd
Watershed Team Leader
U.S. Department of Agriculture Forest Service, Northeastern Area State and Private Forestry

Al Todd is a graduate of Penn State University and the Watershed Hydrology program of the University of Arizona. Al has worked for county government, private consultants and the last 24 years for the USDA Forest Service primarily focusing on watershed restoration and management in Arizona, Idaho, California, and the Northeastern States. Al was the Watershed Director for the Lake Tahoe Basin, Forest Service Liaison to the EPA Chesapeake Bay Program for 7 years, and now serves as the Watershed Program Leader for 20 Northeastern Area states. Al has written numerous articles and technical papers related to watershed restoration, erosion control, riparian dynamics, forest and water quality management and is a two-time winner of the Chief of the Forest Service's National Stewardship Award.

CHESAPEAKE EXECUTIVE COUNCIL

DIRECTIVE NO. 03-01

EXPANDED RIPARIAN FOREST BUFFER GOALS

We, the members of the Chesapeake Executive Council, hereby reaffirm our commitment to restoring the Chesapeake Bay, in part, by protecting and restoring riparian lands along the watershed's thousands of miles of stream and shoreline. Scientific evidence indicates that riparian forest buffers offer the greatest range of benefits of any riparian land use. Such benefits include improved downstream and instream habitats, reduced nutrient and suspended sediment levels and moderated water temperatures, and improved value such as foraging, migration, spawning, nursery and nesting habitat for a variety of wildlife. Based on this evidence, we support increased efforts in the conservation, restoration, and maintenance of forested riparian buffers.

WE ARE PROUD of the progress that each of our jurisdictions has made in achieving the goal set in 1996 fully eight years ahead of the 2010 schedule. To capitalize on the momentum we have created, we commit to the following:

- WE REAFFIRM OUR BELIEF that riparian forested buffers are critical to protecting the streams of the Chesapeake watershed, and as agreed to in the *Chesapeake 2000* agreement, we commit to a continued effort to maximize the miles of streambank and shoreline that are protected by any form of vegetated buffer, especially trees.
- WE RECOGNIZE THAT THERE IS A GREAT OPPORTUNITY to further improve water quality and living resource habitat by continuing to establish forest buffers on the many miles of streams yet to be restored. Our long term restoration goal is beyond our current capacity, so we must seek new public-private partnerships, and encourage the participation of our headwater state partners. We appreciate that our ultimate goal must be to enhance streams and their riparian forests in the years beyond 2010, preserving these buffers over the long-term once they are established.
- WE FURTHER RECOGNIZE THAT URBAN TREE CANOPY COVER offers stormwater control and water quality benefits for municipalities in the Chesapeake Bay watershed and can extend many riparian forest buffer functions to urban settings.
- WE BELIEVE THAT THE CHESAPEAKE BAY PROGRAM is uniquely positioned, as the premier watershed restoration program, to set ambitious goals and to marshal the resources necessary to achieve those goals, and we intend to continue to provide the leadership necessary to assure success.
- Building on our past commitments, WE COMMIT TO THE ADOPTION OF AN EXPANDED SET OF GOALS:
  - Enhance and sustain the integrity of aquatic ecosystems over the long term through conservation and restoration of forests along at least 70% of all streams and shorelines, which translates to about 26,000 miles of additional buffers in our jurisdictions with the near term goal of achieving at least 10,000 miles of riparian forest buffers by 2010. We expect that additional miles will be added to our near term goal based on the tributary strategies to achieve the nutrient and sediment allocations, due to be completed by April, 2004.
  - By 2010, work with at least 5 local jurisdictions and communities in each state to complete an assessment of urban forests, adopt a local goal to increase urban tree canopy cover and encourage measures to attain the established goals in order to enhance and extend forest buffer functions in urban areas.
  - Encourage increases in the amount of tree canopy in all urban and suburban areas by promoting the adoption of tree canopy goals as a tool for communities in watershed planning.

❖ WE THEREFORE DIRECT our agencies and we encourage our partners to begin immediately to accomplish the following:

- Ensure, through monitoring and maintenance, that newly established forested buffers have a well-stocked stand of trees after 5 years.
- Enhance and strengthen the restoration and conservation of riparian forest buffers, wherever possible, on public lands; and, in programs that protect private lands from development.
- Advance our efforts to conserve existing riparian forests along all streambanks and shorelines in order to minimize loss.
- Revise each Bay signatory's Riparian Buffer Implementation Plan with a focus toward the permanent protection of buffers and other program and policy opportunities for an enhanced buffer conservation and restoration program.

❖ WE FURTHER DIRECT our agencies and the Chesapeake Bay Program to seek ways to accomplish the following actions, which we believe will fundamentally enhance the ability to accomplish the goals stated above:

- Ensure that an adequate level of technical service from state and federal agencies is available to landowners and communities for buffer restoration and conservation.
- Provide for the continued use of the Conservation Reserve Enhancement Program as a critical component of riparian forest buffer restoration.
- Utilize existing federal and state incentive programs and develop new programs and partnerships to reach our riparian forest buffer restoration mileage goal and expand buffer widths beyond minimum requirements, promote the use of longer term contracts, encourage the planting of trees on a range of land uses, and emphasize maintenance of buffer vegetation and function.
- Use easements, tax policies, incentives, and other fiscal tools, to strengthen riparian forest conservation commitments.
- Target riparian forest buffer restoration for maximum water quality and wildlife habitat benefit, to the extent feasible, by seeking to increase contiguously forested stream corridors, protect headwater streams, target high nitrogen source areas, and integrate forest buffer restoration with fish passage, stream restoration, and living resource objectives.
- Promote the use of innovative restoration techniques, such as successional plantings, that increase wildlife habitat value and diversity.
- Expand the state of our knowledge about the role of urban tree canopy in supporting riparian buffer functions in cities and urbanizing communities. Develop science-based tools to quantify the benefits of an urban canopy for communities in the Bay watershed and research methods for crediting narrower buffers in urban areas.

December 9, 2003

Urban Forestry Web Resources

American Forests www.americanforests.org

Casey Trees Endowment Fund www.caseytrees.org

Center for Watershed Protection www.cwp.org

Chesapeake Bay Program www.chesapeakebay.net

Cornell Urban Horticulture Institute www.hort.cornell.edu/department/faculty/bassuk/uhi/

District of Columbia Urban Forestry Administration http://ddot.dc.gov/ufa/site/default.asp

Georgia Forestry Commission www.gfc.state.ga.us

Maryland Department of Natural Resources Forest Service, Urban and Community Forestry Program www.dnr.state.md.us/forests/programs/urban/

Pennsylvania Urban and Community Forestry Council www.dcnr.state.pa.us/forestry/pucfc/

TreeLink www.treelink.org

TreeVitalize www.treevitalize.net

USDA Forest Service Northeastern Research Station at Syracuse www.fs.fed.us/ne/syracuse

USDA Forest Service Center for Urban Forest Research http://cufr.ucdavis.edu

USDA Forest Service Northeast Center for Urban and Community Forestry www.umass.edu/urbantree

USDA Forest Service Northeastern Area Urban and Community Forestry Program www.na.fs.fed.us/urban/urban.htm

USDA Forest Service Urban Forestry South www.urbanforestrysouth.org

University of Washington Center for Urban Horticulture http://depts.washington.edu/urbhort/

Virginia Urban Forest Council www.treesvirginia.org

Woods Hole Research Center www.whrc.org